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Sir:

Transmitted herewith for filing is the patent application of:

Inventor: Thomas N. Chalin

For: IMPROVED STEERABLE SUSPENSION SYSTEM

Enclosed are 25 pages of specification including claims, 7 sheets of drawings, FIGS. 1 - 7, a combined Declaration and Power of Attorney, an Assignment and a Verified Statement Claiming Status as a Small Entity Under 37 C.F.R. 1.9(f) and 1.27(c). The filing fee has been calculated as shown below:

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MULTIPLE DEPENDENT CLAIMS = 0			\$130	\$0
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A check in the amount of \$425.00 to cover the filing fee is enclosed herewith. Also enclosed is a check in the amount of \$40.00 for the Assignment Recordation Fee. The commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 11-1543. A duplicate copy of this sheet is enclosed.

Any additional fees required under 37 C.F.R. §1.16.

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Beverly Garrard Spencer

ABSTRACT OF THE DISCLOSURE

An improved steerable suspension system provides light weight and ease of assembly. In a preferred embodiment, a steerable suspension system has a device attached to opposite ends of a tubular axle. The device includes a number of interconnected plates which cooperate to form an axle seat, and to which a king housing portion is attached.

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2. UNITED STATES PATENT OFFICE

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## IMPROVED STEERABLE SUSPENSION SYSTEM

## BACKGROUND OF THE INVENTION

The present invention relates generally to suspension systems utilized on large trucks and tractor-trailer rigs and, in a preferred embodiment thereof, more particularly provides an improved steerable suspension system.

Steerable suspension systems utilized on large truck and tractor-trailer rigs typically include cast or forged axles with king pin housings integrally formed at 15 opposite ends of the axles. In this manner, the spatial relationships between the axle

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and the king pin housings are fixed for particular suspension systems. However, this creates other problems that are not easily resolved.

As an example of the problems encountered with typical steerable suspension systems, the integrally formed axles and king pin housings tend to be heavy, due to 5 constraints of the casting or forging processes.

As another example of the problems encountered with typical steerable suspension systems, the axle portion thereof is usually formed in an I-beam, or modified I-beam, shape. Such shapes may be easily forged or cast, but they do not efficiently utilize the material of which they are formed, and they do not present

convenient surfaces for attachment of brackets, etc., thereto.

As yet another example, typical steerable suspension systems are generally inflexible in their design. If a different offset, or a different axle strength, a different axle length, a different king pin housing configuration, etc., is desired, a completely different casting or forging must be produced and inventoried. Brackets, etc., configured for attachment to a suspension system designed for one application may not be adaptable to a suspension system designed for another application.

From the foregoing, it can be seen that it would be quite desirable to provide an improved steerable suspension system which is flexible in design, reduces weight, is easily assembled, and reduces inventory cost. It is accordingly an object of the 20 present invention to provide such a steerable suspension system. Other objects, benefits, and features of the present invention will become apparent upon careful consideration of the detailed description and accompanying drawings of an embodiment thereof hereinbelow.

SUMMARY OF THE INVENTION

In carrying out the principles of the present invention, in accordance with an embodiment thereof, an improved steerable suspension system is provided which is a combination of a generally tubular axle and a device attached at each opposite end of the axle, utilization of which enables weight to be eliminated, reduces fasteners required for assembly, requires minimal maintenance, is compact in design, and, due to flexibility of the system design, reduces inventory cost.

In broad terms, an improved steerable suspension system is provided by the present invention. The suspension system includes an axle and two devices. The axle is generally tubular and has opposite ends. One of the devices is attached to each of the axle opposite ends. Each device includes a king pin housing configured for receipt of a king pin therein, and an axle seat complementarily shaped relative to the axle.

The device also includes a plurality of interconnected plates. The plates are attached to the king pin housing and the axle. The plates include side plates and an inner plate, the inner plate having a profile formed thereon. The profile is complementarily shaped relative to the axle. The side plates and the profile cooperate to form the axle seat.

The plurality of plates further includes an outer plate outwardly overlying one of the axle opposite ends, and a top plate attached to the side plates. The suspension system also includes a partial upper arm bracket attached to the top plate, the partial upper arm bracket including an opening aligned with an opening formed through the inner plate, and a partial lower arm bracket attached to the axle, the

partial lower arm bracket also including an opening aligned with another opening formed through the inner plate.

Another suspension system is provided by the present invention. The suspension system includes a king pin housing having an opening formed therethrough for receipt of a king pin therein, a generally tubular axle, and an axle seat as part of the axle. The axle seat is complementarily shaped relative to the axle, and is integrally formed with the king pin housing.

In another aspect of the present invention, a steerable suspension system is provided. The suspension system includes a king pin housing, a combined axle and axle seat, an airspring bracket, an airspring, a partial lower arm bracket, and a partial upper arm bracket.

The king pin housing has an opening formed therethrough for receipt of a king pin therein. The axle is generally tubular and has opposite ends. The axle seat is complementarily shaped relative to the axle and is attached thereto. The axle seat is integrally formed with the king pin housing.

The airspring bracket is attached to the axle. It has a generally planar plate extending generally parallel to the axle and an attachment portion attached to the plate. The attachment portion is complementarily shaped relative to the axle and is attached thereto. The airspring is attached to the airspring bracket.

The partial lower arm bracket is attached to the axle. It has a first portion extending generally orthogonal to the axle and has an opening formed therethrough for receipt of a first fastener therein. A second portion is attached to the first portion. It is complementarily shaped relative to the axle and is attached thereto.

The partial upper arm bracket is attached to the king pin housing and axle

seat. It has a first portion extending generally orthogonal to the axle and has an opening formed therethrough for receipt of a second fastener therein. A second portion is attached to the first portion and is complementarily shaped relative to the king pin housing and axle seat, and is attached thereto.

5 In yet another aspect of the present invention, a device is provided for use with a steerable suspension system having a king pin and an axle extending generally transversely relative to the king pin. The device includes a king pin housing having a first opening formed therethrough, the first opening being configured for receipt of the king pin therein, and an axle seat integrally formed with the king pin housing and having a portion thereof complementarily shaped relative to the axle.

#### BRIEF DESCRIPTION OF THE DRAWINGS

10 FIGS. 1A - 1B are front and top elevational views, respectively, of a steerable axle system;

15 FIG. 2 is a side elevational view of a typical steerable suspension system;

FIG. 3 is a front elevational view of a steerable axle system embodying principles of the present invention;

20 FIG. 4 is a cross-sectional view of the steerable axle system of FIG. 3, taken along line 4-4;

FIG. 5 is a rear elevational view of the steerable axle system of FIG. 3;

FIG. 6 is a side elevational view of a steerable suspension system embodying principles of the present invention, the suspension system incorporating the

steerable axle system of FIG. 3; and

FIG. 7 is a front elevational view of another steerable axle system embodying principles of the present invention.

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#### DETAILED DESCRIPTION

Illustrated in FIGS. 1A - 1B is a steerable axle system 10. Only one side of the axle system 10 is shown, as the other side is substantially a mirror image thereof. The axle system 10 includes a cast or forged member 12 which has an integrally formed king pin housing portion 14 and axle portion 16. The king pin housing portion 14 has a king pin (not visible in FIGS. 1A & 1B) received therein in a conventional manner.

The king pin connects to a spindle yoke 18 above and below the king pin housing portion 14. A generally horizontally extending spindle 20 extends outwardly from the spindle yoke 18. The spindle 20 provides for attachment of wheel bearings, wheel hub, etc. (not shown), thereto in a conventional manner. The spindle yoke 18 and spindle 20 rotate about the king pin, thereby also permitting a wheel (not shown) attached to the spindle to rotate about the king pin, and allowing a vehicle on which the suspension system is installed to change its direction of travel.

20 A control arm 22 extends generally horizontally from the lower portion of the spindle yoke 18 and generally orthogonal to the spindle 20. A tie rod 24 is pivotably attached to the control arm 22 by means of a tie rod end or ball joint 26. As shown in FIGS. 1A & 1B, the tie rod 24 is disposed generally orthogonal to the control arm 22 and generally parallel to the axle portion 16, the tie rod extending inwardly from the

control arm. In a conventional manner, rotation of the spindle yoke 18 relative to the king pin housing 14 is, thus, controllable by lateral displacement of the tie rod 24.

The axle portion 16 has a generally I-shaped cross-section. Upper and lower generally horizontally disposed flanges 28, 30, respectively, provide resistance to longitudinally directed bending moments produced, for example, by the weight of the vehicle supported by the axle system 10. It will be readily apparent to one of ordinary skill in the art that generally I-shaped cross-sections are not well suited for resistance to torsion in the direction of a beam's axis.

A generally horizontally disposed plate 32 is formed on the axle portion 16 adjacent the upper flange 28. The plate provides a mounting platform for an axle seat and airspring (not shown). Additionally, note that surfaces of the axle portion 16 are generally either horizontally or vertically disposed. Thus, if it is desired to mount a bracket, airspring, etc., at an inclination other than horizontal or vertical, the bracket, etc., must be fabricated and inventoried especially for that inclination, or a different member 12 having appropriately inclined surfaces must be fabricated and inventoried.

Referring additionally now to FIG. 2, a typical steerable suspension system 34 is shown from a side view thereof, with a king pin housing, spindle, and other outer portions thereof removed for illustrative clarity. The suspension system 34 is of the type known to those skilled in the art as a modified parallelogram, upper and lower arms or links 36, 38, respectively, being pivotably attached to a vehicle frame 40 at fasteners 42, 44, respectively, and to an axle portion 47 of the suspension system at fasteners 48, 50, respectively. The fasteners or pivot points 42, 44, 48, 50 are spaced

apart so that, as the axle portion 47 is displaced vertically relative to the frame 40, the axle portion is rotated somewhat about a transverse axis. Other somewhat similar suspension systems are known as "four-link" suspension systems.

The axle portion 47 has a generally I-shaped cross-section, except that its 5 upper flange 52 is substantially wider than its lower flange 54 at a mounting location for an airspring 60 and axle seat 56. The axle portion 47 has a king pin housing (not shown) integrally formed at each of its opposite ends, similar to the king pin housing portion 14 of the member 12 shown in FIGS. 1A & 1B.

The fasteners 48, 50 are secured in their spatial relationships to the axle 10 portion 47 by means of the axle seat 56 attached to the axle portion. Note that, if it is desired to change the spatial relationships of the fasteners 48, 50 to the axle portion 47 by, for example, rotating the axle seat 56 relative to the axle portion, a different bracket or axle portion would be required to be fabricated and inventoried.

A bracket 58 is attached to the axle seat 56. The bracket 58 is utilized to mount 15 an air bag or airspring 60 to the axle seat 56.

Referring additionally now to FIGS. 3 & 4, an improved steerable axle system 110 embodying principles of the present invention is representatively illustrated. In the following description of the axle system 110 and other apparatus, directional terms, such as "upper", "lower", "above", "below", etc., are used for convenience in 20 referring to elements of the axle system as depicted in the accompanying figures. It is to be understood, however, that the elements may be otherwise oriented, and the axle system 110 may be utilized in other orientations, without departing from the principles of the present invention.

The axle system 110 includes a generally tubular and laterally extending axle

*A* 112. The axle 112 is generally square-shaped, but it is to be understood that other shapes may be utilized for the axle without departing from the principles of the present invention. Only one end of the axle 112 is representatively illustrated in FIG. 3, the other end being similar to the one depicted.

*A* 5 It will be readily appreciated by one skilled in the art that the tubular axle 112 is more efficient in resisting torsion about its axis, as compared to the I-shaped axle portions 16, 47 previously described. Due to this increase in efficiency, the axle 112 may use less material and, therefore, have less weight. Another benefit of the axle 112 is that, where it is desired to increase the strength of the axle, its wall thickness 10 ~~may be increased without affecting its outer side surface 114. Thus, the axle 112 may be strengthened without requiring corresponding changes to brackets, etc., attached thereto.~~

*A* 15 A partial lower arm bracket 116 is attached to the axle 112 by, for example, welding an attachment plate portion 118 thereof to the outer side surface 114. The attachment plate portion 118 may be complementarily shaped relative to the outer side surface 114 of the axle 112. Other methods of attaching the bracket 116 may be utilized, for example, U-bolts, clamps, etc., without departing from the principles of the present invention. The bracket 116 has a portion 120 extending outwardly (i.e., 20 downwardly and forwardly as viewed in FIG. 3, similar to portion 122 shown in FIG. 4) from the attachment portion 118. The portion 120 has an opening 126 formed transversely therethrough for receipt of a fastener, such as fastener 50, therein. In this manner, a lower arm, such as lower arm 38, may be pivotably attached to the axle 112 in the axle system 110.

Proximate each of its ends, the axle 112 is attached to a device 128. The device

128 includes a king pin housing portion 130 and an axle seat portion 132. The king pin housing portion 130 and axle seat portion 132 are combined by a unique construction and arrangement of a top plate 134, an outer plate 136, opposing side plates 138, and the inner plate 124. The plates 124, 134, 136, 138 and the king pin housing portion 130 are attached to each other as shown by conventional methods, such as by welding, to thereby provide a generally hollow box-like assembly, which is substantially lighter in weight than a comparable casting or forging, but which is generally equivalent in strength. Inner side surfaces of the side plates 138 are complementarily shaped relative to the outer side surface 114 of the axle 112, and the inner plate 124 has a profile 140 formed therein, which is also complementarily shaped relative to the outer side surface 114, thereby forming the internal axle seat 132. The outer plate 136 overlies an outer end of the axle 112, and thereby forms a closure over the end of the axle. Each of the plates 124, 136, 138 is attached to the axle 112 as shown by conventional methods, such as by welding the plates to the axle, but it is to be understood that the axle seat portion 132 may be otherwise attached to the axle, for example, by U-bolts, clamps, etc., without departing from the principles of the present invention.

10 The king pin housing portion 130 has an opening 142 formed therethrough. A conventional king pin (not shown) may be installed within the opening 142 and secured therein utilizing a retainer bolt (not shown) or other conventional fastening means. A spindle yoke (such as spindle yoke 18), spindle (such as spindle 20), and control arm (such as control arm 22) may be pivotably attached to the king pin, similar to the manner in which these elements are attached to the king pin housing portion 14 of the axle system 10 described above (see FIGS. 1A-1B).

Since the device 128 is separate from the axle 112 before being attached thereto, the axle may be changed as desired, such as by changing its length, wall thickness, etc., without requiring any changes to the device. Thus, only one device 128 need be inventoried for use with a variety of differently configured axles 112. 5 Similarly, if it is desired to change the device 128, for example, to provide a strengthened device for a particular application, change its configuration, etc., the changed device may still be attached to the same axle 112 without requiring any changes thereto.

A partial upper arm bracket 144 is attached to the device 128 by, for example, 10 welding an attachment portion 146 thereof to the top plate 134. Other methods of 15 attaching the bracket 144 may be utilized, for example, U-bolts, clamps, etc., without departing from the principles of the present invention. The bracket 144 has a 20 portion 148 extending outwardly (i.e., upwardly and forwardly as viewed in FIG. 3, similar to portion 152 shown in FIG. 4) from the attachment portion 146. The portion 25 148 has an opening 150 formed transversely therethrough for receipt of a fastener, such as fastener 48, therein. In this manner, an upper arm, such as upper arm 36, 30 may be pivotably attached to the device 128 in the axle system 110. Thus, the axle system 110 may be utilized in a parallelogram, modified parallelogram, four-link, etc., 35 type of suspension (see FIG. 6), but it is to be understood that, properly modified, the 40 axle system 110 may be utilized in other types of suspensions without departing from the principles of the present invention. Of course, modifications may easily be made 45 to the axle system 110, such as those modifications that would be obvious to one of ordinary skill in the art, for example, to adapt the axle system 110 for use in another 50 type of suspension, differently configure the brackets 144, 116, etc., without 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 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102032 102033 102034 102035 102036 102037 102038 102039 102040 102041 1020

departing from the principles of the present invention.

Referring additionally now to FIG. 5, an improved steerable axle system 160, which utilizes the system 110, is representatively illustrated, the steerable axle system embodying principles of the present invention. Only one side of the axle system 160 is shown, as the other side is substantially a mirror image thereof. The 5 axle system 160 includes the device 128 which has the combined king pin housing portion 130 and axle seat 132. The king pin housing portion 130 has a king pin 162 received in its opening 142 (see FIG. 3) in a conventional manner.

The king pin 162 is pivotably secured to a spindle yoke 164 above and below 10 the king pin housing portion 130. A generally horizontally extending spindle 166 extends outwardly from the spindle yoke 164. The spindle 166 provides for 15 attachment of wheel bearings, wheel hub, etc. (not shown), thereto in a conventional manner. The spindle yoke 164 and spindle 166 rotate about the king pin 162, thereby also permitting a wheel (not shown) attached to the spindle to rotate about the king pin and allowing a vehicle on which the steerable axle system 160 is 20 installed to change its direction of travel.

A control arm 168 extends generally horizontally from the lower portion of 25 the spindle yoke 164 and generally orthogonal to the spindle 166. A tie rod 170 is pivotably attached to the control arm 168 by means of a tie rod end or ball joint 172. 30 As shown in FIG. 5, the tie rod 170 is disposed generally orthogonal to the control arm 168 and generally parallel to the axle 112, the tie rod extending inwardly from the 35 control arm. In a conventional manner, rotation of the spindle yoke 164 relative to the king pin housing 130 is, thus, controllable by lateral displacement of the tie rod 170.

An airspring mounting bracket 174 is attached to the axle 112 by, for example, welding to the outer side surface 114. Other methods of attaching the bracket 174 may be utilized, for example, U-bolts, clamps, etc., without departing from the principles of the present invention. The bracket 174 permits an air bag or airspring 5 176 to be mounted thereto. Note that the airspring 176 may conveniently be otherwise positioned relative to the axle 112 by merely attaching the bracket 174 to the axle in an alternate location, without requiring changes to the axle.

Referring additionally now to FIG. 6, a steerable suspension system 180 is shown from a side view thereof, the steerable suspension system embodying 10 principles of the present invention. The steerable axle system 160 shown in FIG. 5 is utilized in the steerable suspension system 180, however, the device 128, spindle yoke 164, and other outer portions thereof are removed for illustrative clarity.

The suspension system 180 is of the type known to those skilled in the art as a parallelogram, upper and lower arms or links 182, 184, respectively, being pivotably attached to a vehicle frame 186 at fasteners 188, 190, respectively, and to the steerable axle system 110 at fasteners 192, 194, respectively. The fasteners or pivot points 188, 190, 192, 194 are spaced apart so that, as the axle system 110 is displaced vertically relative to the frame 186, the axle 112 does not rotate about its transverse axis. Note that the fastener 192 extends through the aligned openings 150 of the portions 148, 152, and that the fastener 194 extends through the aligned openings 126 of the portions 120, 122. Of course, the suspension system 180 may be configured as a modified parallelogram or other suspension system, wherein the axle 110 does rotate about its transverse axis, however, the applicant prefers that the axle caster not change appreciably through its working range in that case.

If desired, and in order to provide the ability to raise the axle system 110 relative to the frame 186, an air bag 196 may be positioned between the frame 186 and an upwardly extending portion 198 of the lower arm 184. Inflation of the air bag 196 will cause the lower arm 184 to rotate counterclockwise as viewed in FIG. 6, thereby 5 raising the axle system 110. Note that the airspring 176 (see FIG. 5) is not shown in FIG. 6 for illustrative clarity. However, when the axle system 110 is utilized in the system 180, the airspring 176 is attached to the frame 186 in a conventional manner, such as by attaching the airspring to a bracket fastened to the frame 186 in a manner similar to that shown in FIG. 2, and the airspring 176 would be exhausted or vented 10 when the air bag 196 is inflated to raise the axle system 110.

Referring additionally now to FIG. 7, an improved steerable axle system 70 embodying principles of the present invention is representatively illustrated. In the following description of the axle system 70 and other apparatus, directional terms, such as "upper", "lower", "above", "below", etc., are used for convenience in referring to elements of the suspension system as depicted in the accompanying figure. It is to be understood, however, that the elements may be otherwise oriented, and the axle system 70 may be utilized in other orientations, without departing from 15 the principles of the present invention.

The axle system 70 includes a generally tubular and laterally extending axle 20 72. The axle 72 is cylindrically-shaped, but it is to be understood that other shapes may be utilized for the axle without departing from the principles of the present invention. Only one end of the axle 72 is representatively illustrated in FIG. 7, the other end being similar to the one depicted.

It will be readily appreciated by one skilled in the art that the tubular axle 72

is more efficient in resisting torsion about its axis, as compared to the I-shaped axle portions 16, 47 previously described. Due to this increase in efficiency, the axle 72 may use less material and, therefore, have less weight. Another benefit of the axle 72 is that, where it is desired to increase the strength of the axle, its wall thickness may 5 be increased without affecting its outer side surface 76. Thus, the axle 72 may be strengthened without requiring corresponding changes to brackets, etc., attached thereto and without requiring such changed brackets, etc., to be inventoried. Yet another benefit of the tubular axle 72 is that the orientation of brackets, etc., attached thereto may be changed, for example, by rotating or displacing the  
210 brackets, etc., about or along the axle's axis, also without requiring corresponding changes to the brackets, etc., and without requiring such changed brackets, etc., to be inventoried.

215 A disc-shaped end cap 74 is attached to the end of the axle 72 to prevent entry of moisture, debris, etc., thereinto. As shown in FIG. 7, the end cap 74 is welded to the axle 72, but other methods of attaching the end cap may be used, such as threadedly installing the end cap in or onto the axle end.

220 Brackets 78 are attached to the axle 72 by, for example, welding complementarily shaped portions 80 thereof to the outer side surface 76. Other methods of attaching the brackets 78 may be utilized, for example, U-bolts, clamps, etc., without departing from the principles of the present invention. Note that the brackets 78 may be attached at other angular and axial positions relative to the axle 72 without requiring any changes to the brackets or axle.

225 Each of the brackets 78 has a portion 82 extending outwardly (i.e., downwardly and forwardly as viewed in FIG. 7) from the complementarily shaped portion 80. The

portion 82 has an opening 84 formed transversely therethrough for receipt of a fastener, such as fastener 50, therein. In this manner, a lower arm, such as lower arm 38, may be pivotably attached to the axle 72 in the axle system 70.

An airspring mounting bracket 86 is attached to the axle 72 by, for example, 5 welding a complementarily shaped portion 88 thereof to the outer side surface 76. Other methods of attaching the bracket 86 may be utilized, for example, U-bolts, clamps, etc., without departing from the principles of the present invention. Note that the bracket 86 may be attached at other angular and axial positions relative to the axle 72 without requiring any changes to the bracket or axle.

10 The bracket 86 has a planar portion 90 attached above the complementarily shaped portion 88. The portion 90 permits an air bag or airspring 92 to be mounted thereto.

15 Proximate each of its ends, the axle 72 is attached to a device 94. The device 94 includes a king pin housing portion 96 and an axle seat portion 98. The king pin housing portion 96 and axle seat portion 98 are integrally formed by conventional methods, such as casting, forging, etc.

20 The king pin housing portion 96 is similar to the king pin housing portion 14 of the axle system 10. It has an opening 100 formed therethrough. A conventional king pin (not shown) may be installed within the opening 100, and a spindle yoke (such as spindle yoke 18), spindle (such as spindle 20), and control arm (such as control arm 22) may be pivotably attached thereto, similar to the manner in which these elements are attached to the king pin housing portion 14 of the axle system 10 described above.

The axle seat portion 98 is complementarily shaped relative to the outer side

surface 76 of the axle 72. As shown in FIG. 7, the axle seat portion 98 is attached to the axle 72 by being welded thereto, but it is to be understood that the axle seat portion may be otherwise attached to the axle, for example, by U-bolts, clamps, etc., without departing from the principles of the present invention. Note that the axle seat 98 and axle 72 permit the device 94 to be mounted to the axle in a variety of axial and angular positions without requiring changes to the axle or device. Additionally, since the device 94 is separate from the axle 72 before being attached thereto, the axle may be changed as desired, such as by changing its length, wall thickness, etc., without requiring any changes to the device. Thus, only one device 94 need be

10 inventoried for use with a variety of differently configured axles 72. Similarly, if it  
15 is desired to change the device 94, for example, to provide a strengthened device for a  
20 particular application, change its offset, etc., the changed device may still be  
attached to the same axle 72 without requiring any changes thereto.

A bracket 102 is attached to the device 94 by, for example, welding a  
15 complementarily shaped portion 104 thereof to an upper side of the device. Other  
20 methods of attaching the bracket 102 may be utilized, for example, U-bolts, clamps,  
etc., without departing from the principles of the present invention. Alternatively,  
the bracket 102 may be integrally formed as a portion of the device 94. Note that the  
bracket 102 may be attached at other angular and axial positions relative to the  
device 94 without requiring any changes to the bracket or device.

The bracket 102 has two portions 106 extending outwardly (i.e., upwardly and  
forwardly as viewed in FIG. 7) from the complementarily shaped portion 104. The  
portions 106 have openings 108 formed transversely therethrough for receipt of a  
fastener, such as fastener 48, therein. In this manner, an upper arm, such as upper

arm 36, may be pivotably attached to the device 94 in the axle system 70. Thus, the axle system 70 may be utilized in a parallelogram, or modified parallelogram, type of suspension, such as suspension system 34, but it is to be understood that, properly modified, the axle system 70 may be utilized in other types of suspensions without departing from the principles of the present invention. If utilized in a suspension such as that depicted in FIG. 2, the axle system 70 would replace the member 47, axle seat 56, bracket 58, and airspring 60. Of course, modifications may easily be made to the axle system 70, such as those modifications that would be obvious to one of ordinary skill in the art, for example, to adapt the axle system 70 for use in another type of suspension, differently configure the brackets 78, 86, 102, etc., without departing from the principles of the present invention.

Other modifications, substitutions, additions, etc., may be made to the axle systems 70, 110 and/or suspension system 180, which would be obvious to one of ordinary skill in the art, and such changes are contemplated by the principles of the present invention. Accordingly, the foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the present invention being limited solely by the appended claims.

WHAT IS CLAIMED IS:

1           1. An improved steerable suspension system, comprising:  
2           a king pin housing having an opening formed therethrough for receipt of a  
3           king pin therein;  
4           a generally tubular axle; and  
5           an axle seat attached to said axle, said axle seat being complementarily shaped  
6           relative to said axle, and said axle seat being integrally formed with said king pin  
7           housing.

1           2. The steerable suspension system according to Claim 1, wherein said axle has  
2           opposite ends, and further comprising an end cap attached to one of said opposite  
3           ends.

1           3. The steerable suspension system according to Claim 1, further comprising  
2           an airspring bracket attached to said axle.

1           4. The steerable suspension system according to Claim 3, wherein said  
2           airspring bracket has a generally planar plate extending generally parallel to said  
3           axle and an attachment portion attached to said plate, said attachment portion being  
4           complementarily shaped relative to said axle and being attached thereto.

1           5. The steerable suspension system according to Claim 3, further comprising  
2           an airspring attached to said airspring bracket.

1           6. The steerable suspension system according to Claim 1, further comprising a

2 partial lower arm bracket attached to said axle.

1           7. The steerable suspension system according to Claim 6, wherein said partial  
2 lower arm bracket has a first portion extending generally orthogonal to said axle and  
3 having an opening formed therethrough for receipt of a fastener therein, and a  
4 second portion attached to said first portion, said second portion being  
5 complementarily shaped relative to said axle and being attached thereto.

1           8. The steerable suspension system according to Claim 1, further comprising  
2 an upper arm bracket attached to said axle seat and axle.

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1           9. The steerable suspension system according to Claim 8, wherein said upper  
2 arm bracket has a first portion extending generally orthogonal to said axle and  
3 having an opening formed therethrough for receipt of a fastener therein, and a  
4 second portion attached to said first portion, said second portion being  
5 complementarily shaped relative to said king pin housing and said axle seat and  
6 being attached thereto.

1           10. A steerable axle system, comprising:  
2           a king pin housing having an opening formed therethrough for receipt of a  
3           king pin therein;  
4           a generally tubular axle having opposite ends;  
5           an axle seat attached to said axle, said axle seat being complementarily shaped  
6           relative to said axle;  
7           an airspring bracket attached to said axle; said airspring bracket having a  
8           generally planar plate extending generally parallel to said axle and an attachment  
9           portion attached to said plate, said attachment portion being complementarily shaped  
10          relative to said axle and being attached thereto;  
11          an airspring attached to said airspring bracket;  
12          a partial lower arm bracket attached to said axle, said partial lower arm bracket  
13          having a first portion extending generally orthogonal to said axle and having an  
14          opening formed therethrough for receipt of a first fastener therein, and a second  
15          portion attached to said first portion, said second portion being complementarily  
16          shaped relative to said axle and being attached thereto; and  
17          an upper arm bracket attached to said king pin housing and said axle seat, said  
18          upper arm bracket having a first portion extending generally orthogonal to said axle  
19          and having an opening formed therethrough for receipt of a second fastener  
20          therein, and a second portion attached to said first portion, said second portion being  
21          complementarily shaped relative to said king pin housing and said axle seat and  
22          being attached thereto.

1           11. The steerable axle system according to Claim 10, wherein said axle is

2 generally cylindrically shaped.

1           12. The steerable axle system according to Claim 10, wherein said axle seat is  
2 integrally formed with said king pin housing.

1        13. For use with a steerable suspension system having a king pin and an axle  
2        extending generally transversely relative to the king pin, a device comprising:

3            a king pin housing having a first opening formed therethrough, said first  
4        opening being configured for receipt of the king pin therein; and

5            an axle seat, said axle seat being integrally formed with said king pin housing  
6        and having a portion thereof complementarily shaped relative to the axle.

1        14. The device according to Claim 13, further comprising an upper arm  
2        bracket attached to said king pin housing and said axle seat.

1        15. The device according to Claim 14, wherein said upper arm bracket has a  
2        first portion having a second opening formed therethrough for receipt of a fastener  
3        therein, and a second portion attached to said first portion, said second portion being  
4        complementarily shaped relative to said integrally formed king pin housing and axle  
5        seat and being attached thereto.

1 *Sub a1 y* 16. A steerable suspension system, comprising:

2 a generally tubular axle having opposite ends; and

3 a device attached to each of said axle opposite ends, said device including a  
4 king pin housing configured for receipt of a king pin therein, and an axle seat  
5 complementarily shaped relative to said axle.

1 17. The steerable suspension system according to Claim 16, wherein said device  
2 further includes a plurality of interconnected plates, said plates being attached to  
3 said king pin housing and said axle.

1 18. The steerable suspension system according to Claim 17, wherein said  
2 plurality of plates includes first and second side plates and an inner plate, said inner  
3 plate having a profile formed thereon, said profile being complementarily shaped  
4 relative to said axle, and said first and second side plates and said profile cooperating  
5 to form said axle seat.

1 19. The steerable suspension system according to Claim 18, wherein said  
2 plurality of plates further includes an outer plate outwardly overlying one of said  
3 axle opposite ends, and a top plate attached to said first and second side plates, and  
4 further comprising a partial upper arm bracket attached to said top plate, said partial  
5 upper arm bracket including a first opening, said first opening being aligned with a  
6 second opening formed through said inner plate, and a partial lower arm bracket  
7 attached to said axle, said partial lower arm bracket including a third opening, said  
8 third opening being aligned with a fourth opening formed through said inner plate.

PATENT APPLICATION  
Docket No.: WCMI-0005

**DECLARATION AND POWER OF ATTORNEY**

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: "IMPROVED STEERABLE SUSPENSION SYSTEM", the specification therefor being attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

NONE

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

NONE

And I hereby appoint J. RICHARD KONNEKER, Reg. No. 28,867; and MARLIN R. SMITH, Reg. No. 38,310 of the firm of KONNEKER & SMITH, P.C. my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

I request that all correspondence be addressed to:

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660 N. Central Expressway, Ste. 230  
Plano, Texas 75074  
972/516-0030

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Citizenship: U.S.A.

Inventor's signature: 

Date: 3-5-91

PATENT APPLICATION  
Docket No.: WCMI-0005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

VERIFIED STATEMENT CLAIMING STATUS AS A SMALL  
ENTITY UNDER 37 C.F.R. 1.9(f) and 1.27(c)

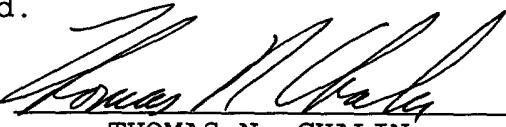
I, Thomas N. Chalin, declare that: I am Vice President of Watson & Chalin Manufacturing, Inc., and am empowered to act on behalf of said concern, that said concern owns all of the rights in the invention in a U.S. patent application entitled: "IMPROVED STEERABLE SUSPENSION SYSTEM" filed: March 5, 1997, that exclusive rights to the invention have been conveyed to and remain with said concern as evidenced by an assignment executed by the inventor on March 5, 1997, and that said concern qualifies as a small business concern as defined in 13 C.F.R. 121.3-18 and reproduced in 37 C.F.R. 1.9(d) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that average number of persons employed on a full time, part time or temporary basis by said concern, including any affiliate(s) controlling or controlled directly or indirectly by said concern or having the power to directly or indirectly control or be controlled by said concern or any affiliate(s) controlled by a third party having the power to control said concern and said affiliate(s), has not exceeded five hundred persons average over the previous fiscal year of said concern of the number of persons employed during each of the pay periods of said fiscal year, that said concern has not assigned, granted, conveyed or licensed and is under no obligation to assign, grant, convey or license, any rights in the invention disclosed and claimed in said application to any person who could not be classified as an independent inventor under 37 C.F.R. 1.9 if that person had made the invention or to any concern which would not qualify as a small business concern or a nonprofit organization as defined in 37 C.F.R. 1.9.

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate (37 C.F.R. 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

3-5-97

Date

  
THOMAS N. CHALIN